

Japan Patent Office
Public Patent Disclosure Bulletin

Public Patent Disclosure Bulletin No.: 10-237267
Public Patent Disclosure Bulletin Date: September 8, 1998
Request for Examination: Not yet made
Number of Inventions: 3
Total Pages: 8

Int. Cl. ⁶	Identification Code	Internal File Nos.
C 08 L 53/02		
	23/14	
	23/16	
	51/06	
	83/10	
	91/08	
FI		
C 08 L 53/02		
	23/14	
	23/16	
	51/06	
	83/10	
	91/08	

Title of Invention: Themoplastic elastomer composition
Patent Application No.: 9-358828
Patent Application Date: December 26, 1997
Priority Application No.: 8-349845
Priority Date: December 26, 1996
Priority Country: Japan (JP)

Inventor: Hiroshi Koyanagi
2-5-8 Higashi Shinagawa, Shinagawa-ku,
Tokyo

Applicant: Sumitomo Bakelite Co., Ltd. 000002141
2-5-8 Higashi Shinagawa, Shinagawa-ku,
Tokyo.

Abstract:

Problem: To provide a novel thermoplastic elastomer composition which can be used in non-coated air bag covers used in automobiles, which could not be obtained with urethane-coated [covers] containing nylon reinforcing meshes.

Means of Solution: A composition comprising copolymer rubbers or thermoplastic elastomers, copolymers of propylene and α -olefins, and graft copolymers of silicone oil and polyolefins, the principal ingredient of which is a styrene elastomer.

Specifications

1. Title of Invention:

Thermoplastic elastomer composition

2. Claims:

- (1) A thermoplastic elastomer composition, characterized in that it consists of:
 - (a) 5–50 wt % hydrogenated block copolymer, the number average molecular weight of which is 70,000 or higher, comprising at least 2 terminal polymer blocks A the principal ingredients of which are vinyl aromatic compounds and at least one intermediate block B the principal ingredient of which is a conjugated diene compound;
 - (b) 20–60 wt % copolymer of propylene and a C₂₋₈ α -olefin with a thermal deformation temperature of 90°C or higher;
 - (c) 5–50 wt % paraffinic oil;
 - (d) 5–70 wt % ethylene- α -olefin copolymer rubber and/or ethylene- α -olefin-non-conjugated diene copolymer rubber with a glass transition temperature of -30°C or lower; and
 - (f) a graft copolymer of silicone oil with a viscosity (JIS Z8803, 25°C) of 50,000 centistokes and a polyolefin in a quantity such that the quantity of the silicone oil is 0.1–20 wt % of the weight of the whole composition.

(2) A thermoplastic elastomer composition, characterized in that it consists of:

- (a) 5–50 wt % hydrogenated block copolymer, the number average molecular weight of which is 70,000 or higher, comprising at least 2 terminal polymer blocks A the principal ingredients of which are vinyl aromatic compounds and at least one intermediate block B the principal ingredient of which is a conjugated diene compound;
- (b) 20–60 wt % copolymer of propylene and a C_{2–8} α-olefin with a thermal deformation temperature of 90°C or higher;
- (c) 5–50 wt % paraffinic oil;
- (e) 5–70 wt % thermoplastic elastomer comprising a blend of a dynamically vulcanized α-olefin copolymer rubber and a polyolefin resin or a blend of a dynamically vulcanized ethylene-α-olefin-non-conjugated diene copolymer rubber and a polyolefin resin, the embrittlement temperature of which is -50°C or lower; and
- (f) a graft copolymer of a silicone oil with a viscosity (JIS Z8803, 25°C) of 50,000 centistokes and a polyolefin in a quantity such that the quantity of the silicone oil is 0.1–20 wt % of the weight of the whole composition.

(3) A thermoplastic elastomer composition in accordance with Claim (1) or (2), in which the silicone oil content in the graft copolymer of a silicone oil and a polyolefin (f) is 5–90 wt %.

3. Detailed Explanation of Invention:

Industrial Field of Application

This invention concerns a thermoplastic elastomer composition which has excellent air bag expandability and resistance to flying apart during the expansion of the air bag, does not require coating, and can be used in the air bag covers of air bag systems used as safety devices in automobiles, etc.

Prior Art

Up to now, urethane with a nylon reinforcing mesh placed in it has been used for air bag covers. When the air bags, which are kept folded up in these covers, are expanded, they fracture in their thin parts which do not have this nylon reinforcing mesh. However, if nylon reinforcing mesh is not used in such air bag covers, cracks are produced during expansion in the parts outside the thin parts which fracture, or the cover flies apart. If the nylon reinforcing mesh is used, the problem of breakage during air bag expansion is solved, but time is required to position the reinforcing mesh at the time the air bag covers are formed, and misalignment of the nylon reinforcing mesh causes a high rate of rejection. Alternatively, there is the drawback that the productivity is lowered by the urethane RIM molding.

Furthermore, there have been many investigations of air bag covers made of thermoplastic resins without using nylon reinforcing nets. In the case of these

covers, the hardness is 40–98, so that they are flexible and do not feel uncomfortable to people, as interior automobile parts, and the air bags expand reliably at temperatures of -40°C to 90°C. However, when the air bags expand, the air bag covers develop cracks in places other than where the fracturing occurs, and it is very difficult to make sure that there are no fragments flying out. Among these air bag covers, there is a good expansion performance in some polyolefin thermoplastic resins at temperatures in the range of -40°C to 90°C in the state immediately after they are formed, but after high-temperature aging tests or weatherability tests, the properties of these covers change due to changes in the phase structure, such as changes in the degree of crystallization of the polyolefin thermoplastic resins, so that the expandability of the air bags and their resistance to flying apart when expanded are not sufficient at temperatures of -40°C to 90°C after these high-temperature aging tests or weatherability tests. Therefore, the present situation is that air bag covers have not yet been developed which have hardnesses of 40–98 and which have excellent expansion performances even after high-temperature aging or weatherability tests, not only immediately after they are formed.

Furthermore, almost all of these air bag covers which have been investigated up to now have been coated in order to protect them from scratches due to fingernails, clothing, etc., prevent them from feeling unpleasant due to tackiness, etc., and prevent color changes due to sunlight. Therefore, air bag covers which do not require coating are desirable from the points of view of productivity and economic value. Up to now, attempts have been made to improve scratch resistance and reduce tackiness, by adding organic lubricants such as higher fatty acids, higher fatty acid esters, or higher fatty acid amides and low-viscosity silicone oil in order to increase the surface lubricity of the molded articles. However, since these materials have a marked tendency to rise to the surface over time, or under the influence of heat, they mar the appearance of the molded articles and reduce their scratch resistances. Various attempts have already been made to improve the appearance and scratch resistance. For example, thermoplastic elastomer compositions (Japan Public Patent Disclosure Bulletin No. 8-319383), etc., have been proposed. But these attempts to improve scratch resistance have been unsatisfactory.

Problems That the Invention Is to Solve

This invention solves the problems with the aforementioned prior art; it concerns a novel thermoplastic elastomer composition which is used in non-coated air bag covers of air bag systems used as safety equipment in automobiles which have spring hardnesses of 40–98 (JIS K6301), which do not require nylon reinforcing mesh, and which could not be achieved with urethane-coated covers containing nylon reinforcing mesh.

Means of Solving These Problems

The inventors performed studies, as a result of which they discovered that air bag covers can be obtained which have excellent expanding abilities and resistance to flying apart when expanded in a wide range of temperatures, from -40°C to 90°C, by the following composition design: among the styrene elastomers which are known as hydrogenated block copolymers which can be used

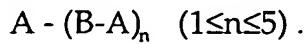
in ingredient (a), ones with number average molecular weights of 70,000 or more, in particular, are used as the main ingredients; the expanding performance at low temperatures is improved by adding and alloying the copolymer rubbers of ingredient (d) or the thermoplastic elastomers of ingredient (e); the expanding performance at high temperatures is improved by adding and alloying the copolymers of propylene and C₂₋₈ α-olefins of ingredient (e); and the scratch resistance and tackiness are improved by means of the graft copolymer of ingredient (f). Furthermore, they discovered that, by using a combination of these optimum ingredients, air bag covers can be obtained which have excellent expanding abilities and resistance to flying apart when expanded in a wide range of temperatures, from -40°C to 90°C, not only immediately after they are formed, but also after high-temperature aging and weatherability tests are performed, and do not require coating.

That is, this invention provides thermoplastic elastomer compositions with excellent high-temperature and low-temperature expanding abilities which are suitable for air bag covers; these thermoplastic elastomer compositions are obtained by melting, mixing, and pelletizing ingredients a, b, c, d, and f, or ingredients a, b, c, e, and f as mentioned below.

- (a) 5–50 wt % hydrogenated block copolymer comprising at least 2 terminal polymer blocks A, the principal ingredients of which are vinyl aromatic compounds, and at least one intermediate block B, the principal ingredient of which is a conjugated diene compound, the number average molecular weight of which is 70,000 or higher;
- (b) 20–60 wt % copolymer of propylene and a C₂₋₈ α-olefin with a thermal deformation temperature of 90°C or higher;
- (c) 5–50 wt % paraffinic oil;
- (d) 5–70 wt % ethylene-α-olefin copolymer rubber and/or ethylene-α-olefin-non-conjugated diene copolymer rubber with a glass transition temperature of -30°C or lower; and
- (f) a graft copolymer of silicone oil with a viscosity (JIS Z8803, 25°C) of 50,000 centistokes and a polyolefin in a quantity such that the quantity of the silicone oil is 0.1–20 wt % of the weight of the whole composition.

Embodiment of Invention

This invention will be explained in detail below. The hydrogenated block copolymers used in this invention are obtained by hydrogenating block copolymers comprising at least 2 terminal polymer blocks A, the principal ingredients of which are vinyl aromatic compounds, and at least one intermediate block B, the principal ingredient of which is a conjugated diene compound. It is a hydrogenated product of a vinyl aromatic compound-conjugated diene compound block copolymer with a structure shown by the following general formula:



This hydrogenated block copolymer must have a hardness of 99 or less, ideally 90 or less, in order to obtain the hydrogenated block copolymer elastomer composition. Therefore, it contains 5–50 wt %, preferably 10–40 wt %, vinyl aromatic compounds. To explain this block structure further, the terminal polymers A consisting primarily of vinyl aromatic compounds have vinyl aromatic compound polymer block structures or copolymer block structures consisting of vinyl aromatic compounds and hydrogenated conjugated diene compounds, with vinyl aromatic compound contents of 50 wt % to 70 wt %. Furthermore, the intermediate block B, the principal ingredient of which is a conjugated diene compounds, has a structure which consists of a hydrogenated conjugated diene compound polymer block or a copolymer block structure consisting of a hydrogenated conjugated diene compound and a vinyl aromatic compound which contains 50 wt % to 70 wt % hydrogenated conjugated diene compound. Moreover, if there are 2 or more polymer blocks consisting primarily of vinyl aromatic compounds and copolymer blocks consisting primarily of hydrogenated conjugated diene compounds, the various polymer blocks may have the same or different structures.

As the vinyl aromatic compounds which constitute the hydrogenated block copolymers, one select one or more compounds selected from, for example, styrene, α -methylstyrene, vinyl toluene, p-tertiary-butyl styrene, etc. Among them, styrene is preferable. Moreover, examples of the conjugated diene compounds, before hydrogenation, which constitute the hydrogenated conjugated diene compounds are one or more of butadiene, isoprene, 2,3-dimethyl-1,3-butadiene, etc.; among them, butadiene, isoprene, and combinations of them are preferable. Furthermore, the molecular structure of the hydrogenated block copolymer may be linear, branched, radial, or any desired combination of these structures. In addition, the number average molecular weight (M_n) of the hydrogenated block copolymer of ingredient (a) used in this invention is 70,000 or higher, preferably 90,000–200,000, and the molecular weight distribution M_w/M_n is 10 or less, preferably 5 or less, and especially preferably 2 or less (M_w : weight average molecular weight). If the number average molecular weight is less than 70,000, sufficient heat resistance cannot be imparted. If the molecular weight distribution exceeds 10, the strength and heat resistance are reduced. The amount of ingredient (a) is 5–50 wt %, preferably 10–45 wt %. If the amount of ingredient (a) is less than 5 wt %, sufficient strength or impact resistance at high or low temperatures cannot be imparted, and if it exceeds 50 wt %, the fluidity is markedly decreased, so that molded articles with good appearances after molding cannot be obtained. Moreover, since the number average molecular weights of the hydrogenated block copolymers of ingredient (A) are large, oil-extended products with the paraffinic oils of ingredient (c) mentioned below can be optionally used to improve workability.

Next, the copolymers of propylene and C_{2-8} α -olefins used as the ingredient (b) of this invention are effective in improving the processability and heat resistance of the resulting composition. For example, one can use random or block copolymers of propylene and small quantities of other α -olefins, such as propylene-ethylene copolymer, propylene-1-hexene copolymer, propylene-4-

methyl-1-pentene copolymer, poly(4-methyl-1-pentene), poly(butene-1), etc. Among these, ethylene-propylene block copolymers are preferable, and copolymers of this kind with ethylene contents of 2–30 wt % are especially preferable. Furthermore, it is desirable to add nucleating agents in order to inhibit changes in properties in high-temperature aging tests and weatherability tests. The melt flow rate (ASTM-D-1238L conditions, 230°C) of this copolymer of propylene and a C₂₋₈ α -olefin is preferably in the range of 0.1–60 g/10 min, especially 0.5–50 g/10 min. If the melt flow rate is less than 0.1 g/10 min, the flowability during molding will be worsened and if it is greater than 60 g/10 min, the heat resistance will be reduced. Therefore, neither is desirable. Moreover, the reason for limiting the thermal deformation temperature (JIS K7207, 4.6 kgf/cm²) to 90°C or higher is that if it is below this temperature, there will be no effect on the heat resistance. The amount of ingredient (b) used is 20–60 wt %, preferably 30–50 wt %. If the amount of ingredient (b) is less than 20 wt %, sufficient heat resistance cannot be imparted, and if it exceeds 60 wt %, the impact resistance at low temperatures will be markedly decreased, so that good expanding performance cannot be exhibited when the air back cover expands at -40°C.

The paraffinic oils used as ingredient (c) in this invention are necessarizing ingredients with the activities of regulating the hardness of the composition obtained and imparting flexibility to it. Mineral oil rubber softeners, referred to as "process oils" or "extender oils," which are generally used to improve the flexibility of rubbers, increase their volumes, or improve their processability, are mixtures of 3 kinds of rings, aromatic, naphthene, and paraffin. If the number of carbons in the paraffin rings are 50% or more of the total number of carbons, these oils are referred to as paraffin-type oils; if 30% to 45% of the carbons are naphthene carbons, they are called naphthene-type oils; and if the aromatic ring carbon content exceeds 30%, they are referred to as aromatic-type oils. The oils used as ingredient (c) of this invention are preferably of the paraffin type; naphthene and aromatic oils are not desirable, due to their dispersabilities and solubilities. The properties of these paraffinic rubber softeners are kinematic viscosities of 20–500 cst at 37.8°C, pour points of -10°C to -15°C, and flash points of 170–300°C. The amount of the paraffinic oil of ingredient (c) used is 5–50 wt %, preferably 10–30 wt %. If the amount of ingredient (c) is less than 5 wt %, the composition obtained will be close to a resin composition, so that its hardness will increase and its flexibility will suffer; in addition, this is undesirable from an economic point of view. If the amount of ingredient (c) used exceeds 50 wt %, the softener is apt to bleed out and there is a possibility of the final product becoming tacky, which will lower its mechanical properties. Therefore, this is not desirable.

Furthermore, the copolymer rubber used as ingredient (d) in this invention is a necessary ingredient in order to impdrove the air bag expandability at -40°C. For the α -olefins in ethylene- α -olefin copolymer rubbers and/or ethylene- α -olefin-non-conjugated diene copolymer rubbers, ones with carbon numbers of 3–15 are ideal. Examples of non-conjugated dienes which can be used are dicyclopentadiene, 1,4-hexadiene, ethylidene norbornene, and methylene norbornene. Polypropylene is ideal as an α -olefin, from the points of view of ease of obtaining

it and improvement in impact resistance. Therefore, so-called EPR and EPDM are ideal as ingredient (d). The ethylene/ α -olefin ratio of the copolymer rubber should be in the range of 50/50–90/10 (weight ratio), and preferably 60/40–80/20. Here, the reason for limiting the glass transition temperature to -30°C or lower is that, if it is higher than -30°C, the expandability of the air bag at -40°C cannot be improved. The amount of ingredient (d) used in the range of 5–70 wt %, preferably 10–65 wt %. If it is less than 5 wt %, the effect of improving the air bag expandability at -40°C by adding the copolymer rubber will not be observed, so that this is not desirable. If the amount of ingredient (d) is greater than 70 wt %, the strength of the elastomer composition at high temperatures will not be maintained, and the air bag expandability at 90°C will not be good; in addition, the shape retention ability at high temperatures will be markedly worsened, and the product will not withstand use as a molded article.

The thermoplastic elastomer used as ingredient (e) in this invention is needed to improve the air bag expandability at -40°C. Suitable α -olefins in the copolymer rubber are ones with carbon numbers of 3–15. As the non-conjugated dienes, one can use dicyclopentadiene, 1,4-hexadiene, ethylidene norbornene, methylene norbornene, etc. An ideal α -olefin in this invention from the points of view of the ease of obtaining it and improving impact resistance is polypropylene. Therefore, an ideal ethylene- α -olefin-non-conjugated diene copolymer rubber in ingredient (e) is so-called EPDM. Ideal ethylene/ α -olefin ratios of the copolymer rubber are 50/50–90/10, ideally 60/40–80/20, by weight ratio. As vulcanizers, ordinary rubber vulcanizers can be used; in particular, besides sulfur, especially desirable ones which one can use include alkylphenyl formaldehyde resins, organic peroxides such as dicumyl peroxide, etc. Besides vulcanizers, vulcanizing adjuvants and antioxidants can be used. The quantity of alkylphenyl formaldehyde resins used should be in the range of 0.5–15 parts by weight per 100 parts by weight copolymer rubber, for the balance of strength and processability. In the case of the organic peroxides, a range of 0.05–1 part by weight per 100 parts by weight of the copolymer rubber is desirable from the point of view of the balance of strength and processability. In order to maintain processability, the polyolefin resin content must be 5 parts by weight per 100 parts by weight copolymer rubber. The ingredient (e) can be obtained by adding a vulcanizer while the blend of copolymer rubber and polyolefin resin is dynamically melt-mixed and vulcanizing it. The reason for limiting the embrittlement temperature of this thermoplastic elastomer to -50°C or lower is that, if the embrittlement temperature is higher than this, the air bag expandability at -40°C cannot be improved. The amount of ingredient (e) can be selected within the range of 5–70 wt %, preferably 10–65 wt %. If the amount of ingredient (e) is less than 5 wt %, no improvement of the air bag expandability at -40°C will be observed as an effect of the addition of the copolymer rubber; therefore, this is not desirable. If the ingredient (e) exceeds 70 wt %, the strength of the elastomer composition obtained at high temperatures cannot be maintained, and not only will the air bag expandability at 90°C not be desirable, but the shape retention ability at high temperatures will be markedly worsened, and the product will not withstand use as a molded article.

The graft copolymer of a silicone oil and a polyolefin which is ingredient (f) in this invention imparts scratch resistance and prevents the tackiness inherent in the elastomers. The kinds of substituents bonded to the main siloxane chain in the molecular structure of the silicone oil ingredient of this copolymer are not particular limited, but dimethyl silicone oil, methylphenyl silicone oil, or alkyl-modified silicone oil are ideal for use. The viscosity of the silicone oil which is ingredient (f) is 50,000 cst or higher, preferably 100,000 cst or higher. If the viscosity of the silicone oil is less than 50,000 cst, the initial scratch resistance and tackiness will be emproved, but over time, or under the influence of heat, the silicone oil will migrate to the surface of the molded article to a marked degree, which is not desirable. Furthermore, the kinds of polyolefin resins used are not particularly limited, but in general one can use polyethylene, polypropylene, or copolymers of ethylene and α -olefins; the α -olefins used may be C_{3-12} ones, e.g., propylene, butene-1, pentene-1, octene-1, 4-methylpentene-1, 4-methylhexene-1, 4,4-dimethylpentene-1, nonene-1, decene-1, undecene-1, dodecene-1, etc. Alternatively, ethylene-ethyl acrylate copolymer (EEA), ethylene-methyl methacrylate copolymer (EMMA), ethylene-vinyl acetate copolymer (EVA), chlorinated polyethylene (CPE), and mixtures of them can be used. Among these, polypropylene is preferable. The silicone oil/polyolefin ratio of the copolymer is in the range of 5/95–90/10, preferably 20/80–60/40. If the weight ratio of the silicone oil is less than 5, the scratch resistance is lowered, and if it exceeds 90, the migration of the silicone oil to the surface over time will be increased. The amount of ingredient (f) used is in the range of 0.1–20 wt %, preferably 0.2–10 wt %, as the silicone oil with respect to the whole quantity of the composition. If the amount of ingredient (f) is less than 0.1 wt % as the silicone oil content, the scratch resistance and stickiness cannot be sufficiently improved, and if it exceeds 20 wt %, the mechanical strength of the composition obtained will be reduced, and this is not desirable from an economic point of view.

Besides the aforementioned ingredients (a)–(f), one can also add inorganic fillers and inexpensive resins such as polystyrene resins, if desired, to the composition of this invention. These not only are advantageous as extenders, for lowering the manufacturing cost, but they also have positive effects such as improving quality (inorganic fillers: imparting shape maintenance under heat; polystyrene resins: improving processability, etc.). Examples of these inorganic fillers are calcium carbonate, carbon black, talc, magnesium hydroxide, mica, barium sulfate, natural silicic acid, synthetic silicic acid (white carbon), titanium oxide, etc. Examples of carbon blacks which can be used are channel black, furnace black, etc. Among these inorganic fillers, talc and calcium carbonate are advantageous from the economic point of view also. Furthermore, ideal polystyrene resins which can be used for this purpose are those which are obtained by radical polymerization and ionic polymerization; their number average molecular weights are 5000–500,000, preferably 10,000–200,000. Desirable molecular weight distributions M_w/M_n are 5 or less. Furthermore, one can also add nucleating agents, external lubricants, internal lubricants, ultraviolet absorbents, hindered amine photostabilizers, hindered phenol antioxidants, colorants, etc., if desired.

The composition fo this invention can be manufactured by ordinary methods which are generally employed to manufacture resin and rubber composi-

tions. Specifically, one can use mechanical melting and mixing methods, employing single-screw and twin-screw extruders, Banbury mixers, various kneaders, Brabenders, rolls, etc. The order in which the various ingredients are added is not limited; for example, all of the ingredients may be mixed to a preliminary extent in a Henschel mixer, blender, etc., and then melting and mixing with one of the aforementioned mixers, or any desired ingredients may be mixed to a preliminary extent and melted and mixed to form a master batch, after which the remaining ingredients are added and melting and mixing are performed. Moreover, ideal temperatures for performing the melting and mixing can be selected from the range of 180–300°C. The hydrogenated block copolymer composition obtained in this way can be fed to an injection molder provided with an air bag cover mold and injection molding may be performed for a short time to obtain an air bag cover. Furthermore, since the composition of this invention is thermoplastic, there is the advantage that the unnecessary burrs, runners, and spools of the injection-molded articles can be recycled by molding and reused as materials for air bag covers.

Working Examples

This invention will be explained in more detail below by means of working examples, but it is not limited by them. The ingredients included in the working and comparison examples shown below are as follows:

Ingredient (a-1):

Septon 4055 (Kuraray Co.): polystyrene-hydrogenated polyisoprene-polystyrene structure; bound styrene quantity 30 wt %; number average molecular weight approximately 170,000.

Ingredient (a-2):

Tafteck H1272 (Asahi Kasei Kogyo Co.): polystyrene-hydrogenated polybutadiene-polystyrene structure; bound styrene quantity 35%; number average molecular weight approximately 120,000 [paraffinic oil (Idemitsu Kosan Co., Diana Process Oil PW-380 (paraffinic process oil, kinematic viscosity 381.6 cst (40°C), 30.1 (100°C), average molecular weight 746, ring analysis values: CA=0%, CN=27%, CP=73%) 35 wt % oil-extended product].

Ingredient (a-3):

Septon 2007 (Kuraray Co.): polystyrene-hydrogenated polyisoprene-polystyrene structure; bound styrene quantity 30 wt %; number average molecular weight approximately 40,000.

Ingredient (b-1):

Asahi Polypro M7646 (Asahi Chemical Industry Co.): melt flow rate 15 dg/min (ASTM D1238), heat deformation temperature 120°C [ASTM D648 (4.6 kgf/cm²)].

Ingredient (b-2):

Asahi Polypro M1700 (Asahi Chemical Industry Co.): melt flow rate 31 dg/min (ASTM D1238), heat deformation temperature 119°C [ASTM D648 (4.6

kgf/cm²].

Ingredient (c):

Idemitsu Kosan Co., Diana Process Oil PW-380 [paraffinic process oil, kinematic viscosity 381.6 cst (40°C), 30.1 (100°C), average molecular weight 746, ring analysis values: CA=0%, CN=27%, CP=73%].

Ingredient (d):

Ethylene-propylene copolymer rubber EP07P [Japan Synthetic Rubber Co.; propylene content: 25 wt %; MFR (230°C)=0.7 g/10 min; Tg: -38°C].

Ingredient (e):

Sumitomo TPE3570 (Sumitomo Chemical Co.; vulcanizer: organic peroxide; embrittlement temperature: -60°C).

Ingredient (f):

Graft silicone concentrate BY27-201 (Dow Corning Toray Silicone Co.; polypropylene content 60 wt %; silicone oil content 40 wt % [silicon oil viscosity 100,000 cst (25°C), specific gravity 0.977 (25°C), index of refraction 1.403 (25°C), pour point -50°C or lower])

The ingredients in Working Examples 1-12 and Comparison Examples 1-10 were thoroughly dry-blended in the proportions shown in the table, after which they were melt-mixed and extruded under the condition of a resin temperature of 180-270°C using a twin-screw extruder and pelletized. The following evaluations were performed by using these pellets:

- (1) Hardness (JIS K6301): Pressed sheets were prepared from the pellets and measured.
- (2) Appearance: An air bag cover with a thickness in the ruptured parts of 0.5 mm and thicknesses of 2-5 mm in the other parts was molded and flow marks, gloss, and the like were evaluated by visual inspection immediately after molding. Furthermore, the cover was inspected after a high-temperature aging test was performed at 110°C for 400 hours; good covers are shown by O, rather bad covers by Δ, and bad covers by ×.
- (3) Shape retention under heat: A heat shape retention test was performed on this molded air bag cover in a 110°C environment. Covers which had good shape retention, no sagging, etc., after 24 hours are shown by O and those which showed sagging, etc., are shown by ×.
- (4) Expansion test::
 - (4)-1. Ordinary state: The molded air bag cover was subjected to air bag expansion tests in 90°C, 23°C, and -40°C environments. The cases in which the bags expanded well from the ruptured parts of the air bag covers are shown by O; the cases in which tears were produced in parts other than the ruptured parts of the air bag covers, the covers flew apart, or the air bags did not expand well are shown by ×.

(4)-2. After high-temperature aging test: A high-temperature aging test was performed on the molded air bag cover in a 110°C environment. After a 400-hour high-temperature aging test, air bag expansion tests were performed in 90°C, 23°C, and -40°C environments. The cases in which the air bags expanded well from the ruptured parts of the air bag covers are shown by O; the cases in which tears were produced in parts other than the ruptured parts of the air bag covers, the covers flew apart, or the air bags did not expand well are shown by ×.

(5) Scratch resistance test: The upper surface of the molded air bag cover was rubbed with a Kanakin No. 3 cloth with a vertical load of 100 gf and an area of contact with the molded article surface of approximately 1 cm²; the rubbing was performed in a reciprocating manner 10 times, at 100 mm per second, for a distance of 100 mm. After the test, the surface of the molded article was inspected visually; the cases in which almost no scratches were visible are shown by O; the cases in which some scratches were visible are shown by Δ; and the bad articles are shown by ×.

The results are shown in Table 1 as working examples; the comparison examples are shown in Table 2. Furthermore, the numerical values of the ingredient (a-2) in the tables are given as wt %, with the extending oil ingredient in ingredient (a-2) excluded. When ingredient (a-2) was used, the numerical values of ingredient (c) in the tables are given as parts by weight, with the wt % of the extending oil ingredient in ingredient (a-2) added to the wt % of ingredient (c). From these results, it can be seen that the air bag covers molded with the composition obtained in this invention have hardnesses of 40–98, and they have excellent air bag expandabilities of -40°C to 90°C.

Table 1

		Working Examples									
		1	2	3	4	5	6	7	8	8*	9
Compo- sition ¹⁾	Ingredient (a-1)	45	5	15	5	30	15	20	0	20	35
	Ingredient (a-2)	0	0	0	0	0	0	0	20	0	0
	Ingredient (a-3)	0	0	0	0	0	0	0	0	0	0
	Ingredient (b-1)	25	55	25	25	30	33.5	37.5	0	37.5	28.5
	Ingredient (b-2)	0	0	0	0	0	0	0	0	37.5	0
	Ingredient (c)	5	5	35	5	5	15	10	10	10	15
	Ingredient (d)	22.5	32.5	22.5	62.5	22.5	34	30	30	0	0
	Ingredient (e)	0	0	0	0	0	0	0	0	37.5	0
	Ingredient (f)	2.5	2.5	2.5	12.5	2.5	2.5	2.5	2.5	2.5	2.5
	Hardness	65	95	70	90	75	80	90	90	90	85
Appear- ance	Immediately after molding	▲	▲	▲	▲	▲	▲	○	○	○	○
	After high-temperature aging test	▲	▲	▲	▲	▲	▲	○	○	○	○
Evalua- tion Expansion test	Shape retention under heat		▲	○	▲	○	○	○	○	○	○
	Ordinary state	90°C	0	0	▲	▲	○	○	○	○	○
		23°C	0	0	0	0	○	○	○	○	○
		-40°C	0	0	0	▲	○	○	○	○	○
	After high- temperature aging test	90°C	0	0	▲	▲	○	○	○	○	○
		23°C	0	0	0	0	○	○	○	○	○
		-40°C	0	0	0	▲	○	○	○	○	○
		Scratch resistance test	0	0	0	▲	○	○	○	○	○
		Abrasion test	0	0	0	▲	○	○	○	○	○

1) Wt %
* [Second "8" is in original - Trans.]

Table 2

		Comparison Examples								
		1	2	3	4	5	6	7	8	9
Composition ¹⁾	Ingredient (a-1)	55	0	0	0	0	20	5	5	20
	Ingredient (a-2)	0	55	0	0	0	0	0	0	0
	Ingredient (a-3)	0	0	20	0	0	0	0	0	0
	Ingredient (b-1)	25	25	37.5	65	0	185	175	175	0
	Ingredient (b-2)	0	0	0	0	65	0	0	0	0
	Ingredient (c)	5	5	10	5	5	54	5	5	11
	Ingredient (d)	12.5	12.5	30	35	35	5	75	0	0
	Ingredient (e)	0	0	0	0	0	0	0	75	19
	Ingredient (f)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	50
	Hardness	50	50	90	99	99	60	70	70	75
Evaluation	Immediately after molding	x	x	x	0	0	x	x	x	0
	After high-temperature aging test	x	x	x	0	0	x	x	x	▲
	Shape retention under heat									
	Expansion test	0	0	x	0	0	x	0	0	x
			90°C	x	x	0	0	x	x	0
			23°C	0	0	0	0	0	0	0
			-40°C	0	0	x	0	x	x	0
	Scratch resistance test	90°C	x	x	0	0	x	x	x	x
		After high-temperature aging test	23°C	0	0	0	0	0	0	0
			-40°C	0	0	x	0	x	x	0
	Abrasion test	0	0	0	0	0	0	0	0	0

¹⁾ Wt %

Effects of Invention

With air bag covers molded from the composition of this invention, good expansion of the air bag can be obtained without cracks in parts other than the rupture parts, when the air bags expand at temperatures of -40°C to 90°C, and without the covers flying apart. Furthermore, these covers have long-term reliability, such as resistance to high-temperature aging, weatherability, etc. In addition, they have better molding workability and productivity and allow simpler color matching than convention air bag covers made of urethane with nylon mesh reinforcement. They also have extremely great use values, such as low costs.